

# EVALUATION OF ROLE OF ANTIBIOTIC CEMENT IMPREGNATED INTRAMEDULLARY NAIL IN INFECTED LONG BONE FRACTURES

Mantri D.\*

Soni S.K.\*\*

Sonkar D.K.\*\*\*

## ABSTRACT

Infected long bone fracture is a debilitating disorder. Traditionally treatment of infected long bone fracture follows the multistage procedure such as debridement and systemic antibiotics with temporary fixation and then permanent fixation and bone grafting when required or bone transport. For the treatment of infected long bone fracture single staged procedures such as debridement and application of Ilizarov fixator and limb reconstruction system (LRS) are also available but these procedures are technically demanding, need good patients compliance and regular long term follow up. This study was to evaluate the role of antibiotic cement impregnated intramedullary nail (ACIIN) in treatment of infected long bone fractures. ACIINs provide a high concentration of antibiotics locally, provide mechanical stability, good infection control, promotes bone union by simple and one stage procedure.

We prospectively studied a cohort of 25 culture positive cases with infected long bone fracture with bone defect less than 2 cm (22 tibia and 3 femur), mean age being 35.4 year were treated by ACIINs. Most common organism isolated in culture was staphylococcus aureus. Infection control was judged on the basis of discharge through the wound and laboratory parameters at regular follow up. 24 cases achieved infection control and bone union without need of other secondary procedure and only one patient shows poor result that lost to follow up. So we find ACIINs as single stage procedure for controlling infection, providing mechanical stability and there by promoting bone union in infected long bone fracture.

**Key words:** Antibiotic Cement impregnated intramedullary nail [ACIINs]; Infected long bone fracture.

## INTRODUCTION

Infected long bone fracture is a debilitating disorder that still poses a very complex problem to the surgeon today in term of cost and long duration of treatment.<sup>1</sup> Causes of infected long bone fracture are generally inherent to the fracture, like compound fracture, loss of soft tissue or bone, severe comminution and gross displacement, insufficient immobilisation etc.<sup>2</sup> Traditionally treatment of infected long bone fracture follows the multistage procedure such as debridement and systemic antibiotics with temporary fixation and

than permanent fixation and bone grafting when required or bone transport.<sup>2,3</sup> For the treatment of infected long bone fracture single staged procedures such as debridement and application of Ilizarov fixator and limb reconstruction system (LRS) are also available but these procedures are technically demanding, costly, requires long term follow up, low patient compliance and have significant complications. These procedures are best suited for large segmental bone defect<sup>4</sup> and both these procedure do not address to the infection control. This led to development of

\* Assistant Professor  
\*\* Resident  
\*\*\* Professor

Address for correspondence:  
Dr. Susheel Soni  
Resident, Dept of Orthopaedics,  
MGMMC and MY Hospital,  
Indore, MP 452001

infection control by local antibiotic delivery systems, initially antibiotic cement beads then antibiotic cement impregnated intramedullary nail (ACIINs). The antibiotic cement beads control infection and fills dead space but does not provide any mechanical stability. Also require another procedure to remove and at time difficult to remove. Antibiotic cement impregnated intramedullary nail (ACIINs) provides a high concentration of antibiotics locally, fills dead space, gives good mechanical stability at fracture site and there by promotes bone healing.<sup>5,6</sup> Thus ACIINs provides all advantages of cement beads.<sup>7</sup> This study was undertaken to analyze the usefulness of antibiotic cement impregnated intramedullary nail in case of infected fracture of long bones.

## MATERIAL AND METHOD

This non randomised prospective study was undertaken at our institute in department of Orthopaedics and Traumatology after approval from Institutional Review Board (Scientific). We studied a cohort of 25 patients who had undergone treatment by antibiotic cement impregnated intramedullary nails (ACIINs) for infected fracture of long bone during June 2012-July 2014. Study included all patients between age 18 yrs-60 yrs with Primarily infected fracture (in which no primary intervention had been done) and secondarily infected fractures (in which the prior intervention was done and got infected) with bone defect less than 2cm. preoperative investigation CBC, ESR, CRP done in all patients. All cases were culture positive. Open wound Gustilo type I, II & IIIA were included. Patients with pathological fracture, immunocompromise and other comorbid condition, bone gap defect more than 2cm were excluded. Functional results were evaluated with regard to control of infection, bony union using RUST score,<sup>15</sup> clinical assessment of fracture union,<sup>16</sup> compliance of patient and complication.

## SURGICAL TECHNIQUE

Preoperative planning needed to determine appropriate size and diameter of nail and also important to know whether patient is allergic to

some antibiotic as those will not be mixed with bone cement and decrease the procedure time intraoperatively. In primary cases (i.e. without prior intervention) radical debridement of wound and sinus was done by opening the wound and fracture site with excision of infected bone ends and soft tissue. In addition to above implant removal was done in secondary cases. Medullary canal was reamed with reamers of increasing size so as to debride canal completely, culture swab taken from reamed material and sent for culture sensitivity test. Then medullary cavity thoroughly irrigated by antiseptic solution and normal saline with help of K-90 catheter and 100 ml syringe.

In this study K-nail was used for both femur and tibia of diameter 1 mm less than last reamer size and length measured either by pre-operative X-ray or intra-operatively under C-arm guidance. The size of eye of k nail was widened for locking locking bolt by electric drill using metal cutting drill bit [Figures 5 & 6]. In case of tibia, proximal end of the nail (at proximal one fourth and distal three fourth junction) was bend by nail bender like Herzogs bend of tibia interlocking nail (Figure 4). A SS wire loop was attached in proximal eye for easy removal in future (Figure 7). Thermostable Antibiotics 1gm of vancomycin powder and 1.5 gm powder of cefuroxime sodium mixed with 20 gm gentamicin impregnated PMMA bone cement powder before mixing solvent, added then solvent added and then cement paste inserted in nail slot sparing the k nail eyes. Cement outside the nail was removed so that original outer diameter of nail remains unchanged then setting and hardening is allowed and then nail is ready (Figure 2). Antegrade insertion of nail for both femur and tibia cases. Proximal and distal locking done by free hand technique. Wound was again irrigated thoroughly and closure performed if possible otherwise skin grafting done on same sitting or later depending on wound size.

Postoperative management as routine protocol like any other intramedullary nailing. Antibiotic as preoperative culture report continued till culture sensitivity report of medullary reaming was available

then modify antibiotics according to culture sensitivity report. A complete blood count (CBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) levels were performed initially and then at fortnightly intervals regularly to record rising or falling trends till 2 months. After 2 months patients followed up every month upto six month then in every two month. On every visit patients was evaluated as per above clinical, radiological and laboratory parameter for bone union.

Why K used in this study nail and why modification needed in this nail preparation:-using a modified k nail has following advantages -

- (1) Clover leaf shape which holds cement in slot, provides rotational stability and rigidity (Figure 1).
- (2) Slot of k nail which accommodate good amount of cement (Figure 2).
- (3) Cement could be filled in the slot not over the surface so that outer diameter of nail does not change (Figure 3).
- (4) Cement mantle doesn't remain insitu while nail removed which could happen with v nail and other ACIINs with cement on the surfacedue to debonding.
- (5) Universal acceptance because herzogs bend could be made in proximal end to accommodate in medullary canal of tibia

(Figure 4). K nail used in other long bone femur and humerus as well.

- (6) Custom preparation of locking holes for static fixation and rotational stability (Figures 5, 6 & 8).
- (7) Attaching SS wire loop in proximal end for easy removal in future (Figure 7).

**RESULT**

25cases of infected long bone fractures (22 tibia and 3 femur) with 23 patients being male were treated with antibiotic cement impregnated intramedullary nail (ACIIN). Meanage being 35.4 years (range 18-60 years). Roadtraffic accident was the most common mode of injury andmost common isolated organism on culture was staphylococcus aureus (80%). Average duration for infection control was 3.7 weeks and infection control was indicated by decrease in inflammatory marker like differential leukocyte counts, ESR and CRP. Wounds was healed in average duration of 4.1 weeks. Only 5 patients needed split thickness skin graft for wound closure. No secondary procedure needed to hasten the bone union because 96% patients shows bone union without any other procedure. Bone grafting not required because docking at fracture site. 5 patients showed average shortening of 0.36cm but in any case it was not more than 2cm.

**Table 1**  
**Criteria for assessment of the result**

S.No.	Variable	Excellent	Good	Fair	Poor
1	Infection at 4 weeks	Control	Control	Control	Not control
2	Wound healed at	5 weeks	7 weeks	10 weeks	Not heal
3	Radiological union at 6 month (RUST Score)	12 score	10 score	8 score	4 score
4	Weight bearing without pain at 6 months	Yes	Yes	No	No
5	Neurovascular complication	Absent	Absent	Absent	+/-
6	Patient compliance	Very good	Good	Fair	Poor compliance
7	Results in out of 25 patients	5	15	4	1
8	Percentage	20%	80%	16%	4%

(RUST Score = Radiological union scale for tibia)

In this study 20% patients showed excellent result with fracture union in average duration of 4.9 months and 60% patients showed good result in which fracture united in average duration of 7.8 months. 4 patients shows fair result with mean duration of union 10.4 months. 1 patient has poor result and lost to followed up.

## DISCUSSION

Infected long bone fractures requires procedure to control infection, provide stability, and achieve union. Surgical debridement and delivery of antibiotic locally and systemically are used to control the infection.<sup>8</sup> Local antibiotic therapy results in high local concentration of antibiotic with minimum systemic level.<sup>8</sup> Antibiotic impregnated PMMA beads are used in treatment of osteomyelites and infected open fracture.<sup>9</sup> However a second procedure is required to remove the beads. The infected foci within the bone are surrounded by a sclerotic, relatively avascular bone covered by a thickened periosteum, scarred muscle and subcutaneous tissue. This avascular envelope of scar tissue leaves systemic antibiotics essentially ineffective.<sup>10</sup> This necessitates the use of locally antibiotic delivery system. Gentamicin has been the most widely used agent followed by vancomycin.<sup>8,11</sup> In this study we use another heatstable antibiotic cefuroxime sodium. These antibiotics have shown to be heat stable with good elution properties from bone cement.<sup>8,12</sup> Use of these antibiotics with bone cement widens the spectrum of activity and also enhances the elution properties of these antibiotics.<sup>11,13</sup> The effectiveness of the antibiotic impregnated cement beads in the control of bone infection is well established. However, they offer no mechanical stability and are difficult to remove after few weeks.<sup>14</sup> ACIINs fills dead space, provide good stability at fracture site, easy to remove, and also provides all the advantages of the cement beads. A high local concentration of antibiotics and low systemic side effects with good mechanical stability are the major advantage of ACIINs.<sup>8</sup>

Raghuram Thonse, Janet D. Conway (2007)

has studied cases of infected non-union with bone defects in 52 patients. They were able to achieve osseous union by use of ACIIN in 84% cases with bone defect but 27% patient's required additional procedure to hasten osseous union. They reported infection control in 95% of their cases. In this study ACIINs was made with use of a chest tube as a template.<sup>6</sup>

In study by Ashok k Shyam, Parag K Sancheti et al. (2009) only three patients achieved primary bone union with the use of ACIIN, of which two patients did not have any bone defect and one patient had a bone defect of 2 cm. In other patients with bone defects more than 2 cm needed secondary procedure for infection control and bony union.<sup>10</sup>

In this study 80% patients showed good to excellent results. 20% patient shows fair result in which fracture united in 10.4 months. One patient has poor result that lost to follow up. None of the patients required additional procedure to hasten osseous union. Average time for infection control was 3.7 weeks. Mean duration of follow up in our study was 16.04 months.

## MERITS OF ACIINS

1. Simple, feasible and cost effective procedure.
2. Custom made locking holes and locking bolts provides stability.
3. Diameter of the nail does not changes because cement is filled in k nail slot not applied over nail surface.
4. Easy removal because ss wire loop is attached to eye of the k nail.
5. Easy to prepare intraoperatively.
6. Control of infection, stability, bone union achieved by a single stage procedure.
7. Planning for soft tissue plastic procedure is easier.
8. Removal of implant not mandatory.
9. Very less chances of cement mantle to left insitu while removal.

10. Routine postoperative protocol as of any intramedullary nailing procedure.

### DEMERITS OF ACIINS

1. Loosening of screw causes pain at local site.
2. In case of Improper size or improper insertion of nail, SS wire loop irritate patellar tendon and causes knee pain.
3. Readymade ACIIN are not easily available.

### CONCLUSION

We find in our study that antibiotic cement impregnated intramedullary nail (ACIINs) is a good procedure to achieve early infection control, provide stability and bone union with single stage procedure in infected long bone fractures with bone gap defect less than 2cm. The ACIINs enhance bone healing by reducing infections, it also reduces the chances of chronic osteomyelites and non union. It is a simple, cost effective, feasible and single stage procedure with excellent and good results for infected fracture of long bones with bone defect less than 2 cm.

### REFERENCES

1. Toh CL, Jupiter JB. The infected nonunion of the tibia. *Clin Orthop Relat Res* 1995;315:176-91.
2. Court-Brown CM. Fractures of the tibia and fibula. In: Bucholz RW, Heckman JD, Court-Brown CM, editors. *Rockwood and Green's fractures in adults*. 6th ed. Lippincott Williams and Wilkins; 2006. p. 2080-146.
3. Ueng SW, Chuang DC, Cheng SL, Shih CH. Management of large infected tibial defects with radical debridement and staged double-rib composite free transfer. *J Trauma* 1996;40:345-9.
4. McKee MD, Yoo DJ, Zdero R, Dupere M, Wild L, Schemitsch EH, et al. Combined single-stage osseous and soft tissue reconstruction of the tibia with the Ilizarov method and tissue transfer. *J Orthop Trauma* 2008;22:183-9.
5. Qiang Z, Jun PZ, Jie XJ, Hang L, Bing LJ, Cai LF. Use of antibiotic cement rod to treat intramedullary infection after nailing: Preliminary study in 19

6. Thonse R, Conway J. Antibiotic cement-coated interlocking nail for the treatment of infected nonunions and segmental bone defects. *J Orthop Trauma* 2007;21:258-68
7. Rajesh dhanasekhar et al. Antibiotic cement impregnated nailing in management of infected non union of femur and tibia :Kerala J Orthop 2013; 26:93-97.
8. Zalavras CG, Patzakis MJ, Holtom P. Local antibiotic therapy in the treatment of open fractures and osteomyelitis. *Clin Orthop Relat Res*. 2004;427: 86-93.
9. Henry SL, Ostermann PA, Seligson D. The prophylactic use of antibiotic impregnated beads in open fractures. *J Trauma*. 1990;30:1231-8.
10. Ashok K. Shyam, Parag K Sancheti et al.: use of antibiotic cement impregnated intramedullary nail in treatment of infected non-union of long bones. *Indian j orthop*. 2009 oct.;43 (4) :396-402
11. Koo KH, Yang JW, Cho SH, Song HR, Park HB, Ha YC, et al. Impregnation of vancomycin, gentamicin, and cefotaxime in a cement spacer for two-stage cementless reconstruction in infected total hip arthroplasty. *J Arthroplasty* 2001;16:882-92.
12. Lindsey RW, Probe R, Miclau T, Alexander JW, Perren SM. The effects of antibiotic-impregnated autogeneic cancellous bone graft on bone healing. *Clin Orthop Relat Res*. 1993;291:303-12.
13. Gallo J, Kolár M, Florschütz AV, Novotný R, Pantucek R, Kesselová M. In vitro testing of gentamicin-vancomycin loaded bone cement to prevent prosthetic joint infection. *Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub* 2005;149:153-8.
14. Patzakis MJ, Wilkins J, Wiss DA. Infection following intramedullary nailing of long bones: diagnosis and management. *Clin Orthop Relat Res* 1986;212:182-91.
15. B. W. Kooistra, B. G. Dijkman, J. W. Busse: "The radiographic union scale in tibia fracture: reliability and validity". *J of ortho. Trauma*, vol.24, suppl.1, pp. s81- s86. 2010.
16. S. Morshed, L. Corrales et al.: "outcome assessment in clinical trial of fracture- healing". *Jbjs am*. Vol.90. suppl.1. pp.62-67. 2008.